Strengthening of Bitumen Road by using Rubber Additives

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***Abstract*— Roads are vital for the transport of the goods and passengers. So roads should be durable and strong. The roads should be worthy for its construction cost. And also it should be suitable for all the weather condition prevailed in India. But the grade of bitumen produced in India without admixtures are not durable and strong. The next problem we are facing the waste management. By analysing these two issues, we discussed the addition of waste materials as an additive for improving the bitumen quality and strength. The major grade of bitumen used in India is 60/70. So we choose the same grade of bitumen for proceeding our project. We are using poly propylene, rice husk ash and the combination of glass powder and crumb rubber. These additives are added in different proportion and check the durability, penetration, stability, ductility, flow value. The aggregates and filler are taken as per the IRC recommendation. So by this experimental study we are scoping not only to improve the quality of Dense Bitumen Macadam (DBM) but also help in waste management.**

***Keywords*— Bitumen, Poly propylene, Rice husk ash, Glass powder and Crumb rubber.**

I. INTRODUCTION

Pavement consists of more than one layer of different materials supported by a layer called sub grade. Generally pavements are of two types namely flexible pavement and rigid pavement based on the design considerations. . Flexible pavements are so named because the total pavement structure deflects or flexes, under loading. A flexible pavement structure composed of several layers of material. The layer consists of a wearing surface at the top, the base course followed by the sub-base course-cum-drainage layer below. This consists of a wearing surface at the top, the base course followed by the sub-base course – cum – drainage layer below. The lowest layer is the compacted soil subgrade which has also the lowest stability among the four typical flexible pavement components. Each of the flexible pavement layers above the subgrade, viz., sub-base, base course and surface course may consists of one or more number of layers of the same or slightly different materials and specifications. The flexible pavement structure is usually designed for a life of 15 years or more, but will need re-surfacing or strengthening layers to be added/ laid periodically on the surface depending on the functional and structural deterioration or damages caused due to the combined effect of traffic and weather.

Bituminous Paving Mixes

The top layer or surface course of flexible pavements of important roads has to withstand high stress conditions and wear and tear due to traffic loads.

Constituents of bituminous mix

The constituents of a dense graded bituminous mix to be used as a surface course of a flexible pavement are:

- Coarse aggregate
- Fine aggregate
- Filler
- Bituminous binder

Requirements of design-mix

The bituminous mix is designed in the laboratory considering the stability of the mix, Flexibility or deformation at failure, Voids content, Durability.

MORTH specification for Aggregate

Nominal Aggregate Size	19 mm	13 mm
Layer thickness	50 to 65 mm	30 to 40 mm
Sieve size in mm	Penetration passing, By weight	
	Grade 1	Grade 2
26.5	100	-
19	79 - 100	100
13.2	59 – 70	70 – 100
9.5	52 - 72	70 – 88
4.75	35 – 55	53 - 71
2.36	28 – 44	42 - 58
1.18	20 – 34	34 – 48
0.6	15 – 27	26 – 38
0.3	10 – 20	18 – 28
0.15	5 – 13	12 – 20
0.075	2 – 8	4 -10
Bitumen Content, % by weight of total mix	5.0 to 6.0	5.0 to 7.0
Bitumen grade	VG 30 (Penetration 65)	VG 30 (Penetration 65)

B. Rice Husk Ash (RHA)

The rice husk ash is a potential source of amorphous reactive silica, which has a variety of applications in materials science. Most of the ash is used in the production of Portland cement. When burnt completely, the ash can have a blaine number of as much as 3,600 compared to the blaine number of cement between 2,800 and 3,000, meaning it is finer than cement. Rice hulls are a low cost material from which silicon carbide "whiskers" can be manufactured. The SiC whiskers are then used to reinforce ceramic cutting tools, increasing their strength tenfold. So it will give strength to the bitumen mix.

- Rice husk ash is collected from nearby paddy field, Neyyattinkara.
- Rice husk ash is sieved in 75 micron IS sieve and use.

C. Polypropylene

The properties of polypropylene depend on the molecular weight and molecular weight distribution, crystallinity, type and proportion of comonomer (if used) and the isotacticity. In isotactic polypropylene, for example, the CH3 groups are oriented on one side of the carbon backbone. This creates a greater degree of crystallinity and results in a stiffer material that is more resistant to creep than both atactic polypropylene and polyethylene.

- Poly propylene is collected from waste plastics
- Mostly the bottle caps are used

D. Glass Powder

The glass has good insulating properties. Since it has high melting point and boiling point than bituminous substance, it has the ability to withstand the temperature variations. The glass powder will easily blend with the bitumen in wet process. So it can be used as a good additive.

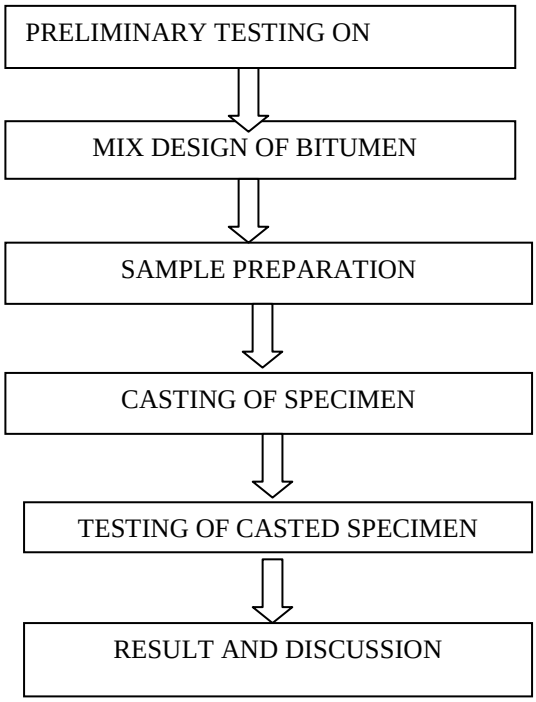
- Glass powder is collected from Glass Industry
- Glass powders will give additional strength to bitumen

E. Crumb Rubber

Crumb rubber is recycled rubber produced from automotive and truck scrap tires. During the recycling process, steel and tire cord (fluff) are removed, leaving tire rubber with a granular consistency. Continued processing with a granulator or cracker mill, possibly with the aid of cryogenics or by mechanical means, reduces the size of the particles and the particles are sized and classified based on various criteria including colour (black only or black and white). The granulate is sized by passing through a screen, the size based on a dimension (1/4 inch) or *mesh* (holes per inch : 10, 20, etc.). Crumb rubber is often used in artificial turf as cushioning.

- Crumb rubber is a waste form of rubber which is produced from waste tyres
- Crumb rubber is added in bitumen by wet process

II. METHODOLOGY



III. TEST ON AGGREGATE

A. Aggregate Crushing Test

Test Result:

Total weight of dry sample taken, W_1 (kg) = 2890

Weight of proportion passing 4.75mm IS sieve, W_2 (kg)= 580

Aggregate crushing value = (W2/W1) x 100
=(580/2890)x100
=20%

IRC and BIS have specified that the aggregate crushing value of coarse aggregate used for pavement at surface should not exceed 30%. Here, the result obtained is 20%. Hence it confirms to IRC and BIS

B. Impact Test

Test Result:

Total weight of dry sample (W_2) = 276.5gm

Weight of portion passing 2.36mm sieve (W_2) = 59.6gm

Aggregate Impact Value = (W_2/W_1) x 10

= (59.6/276.5) x 100

= 21.55

Therefore the Impact Value of the given sample of aggregate = 21.55%

The aggregate impact value of given sample of aggregate is obtained as 24% and hence it is satisfactory for road surfacing and it can be used for all types of road pavement construction as per IRC.

C. Test on Bitumen

Determination of Penetration Value of Bitumen

Test Result:

First Reading = 6.6 mm

Second Reading = 6.2 mm

Third Reading = 5.9 mm

Average penetration value = (6.6 + 6.2 + 5.9)/3

= 6.23mm

As per IRC specification for 60/ 70 grade bitumen the penetration value should be in between 6 to 7 mm. Here we get 6.23 mm. Hence it is used for the road construction.

D. Determination of Ductility of the Bitumen

Test Result:

Sl. No	Description of Bitumen	Specimen 1		Specimen 2		Average Value
		Initial Value	Final Value	Intial Value	Final Value	
		cm	cm	Cm	cm	Cm
1	Ordinary	0	66	0	52.5	59.25

IV. CONCLUSIONS

Bitumen mix with and without the addition of additives are used for the study. In this study, we use poly propylene, rice husk ash and the combination of glass powder and crumb rubber and is added according to wet mix method. Following are the conclusions obtained:

- The optimum bitumen content obtained for the test without additives is 5% with a stability value of 21.929kN and a flow value of 5mm.
- The rice husk ash, polypropylene and combination of glass powder and crump rubber of bitumen gives stability value 18.79, 25.118, 26.257 kN respectively.
- From ductility value and penetration test it show maximum value for the modified bitumen with glass powder and crump rubber
- From the experiment it is observed that the additives has the potential to improve the structural resistance to distress that occur in pavement as a result of increased traffic load.
- Overall results showed that the addition of polypropylene and the combination of glass powder and crumb rubber will be beneficial in improving the properties of the flexible pavement.
- From the Marshall Stability test we can conclude that the strength of bitumen is increased when glass powder and crumb rubber is use as additive. There is

an increase of 20% of stability value when compared to ordinary bitumen. 4% of the glass powder and rubber (2% each of glass powder and rubber) gives the high stability value. Thus by using the above mentioned additive we can not only increase the stability but also reduce the waste materials.

- The study also shows that it is more economical than ordinary bitumen.

REFERENCES

[1]. S.K.Khanna, "**Highway Engineering**", tenth edition, published by Nem Chand & Bros., Civil Lines, Roorkee (2014)

[2]. Nayeem Ahmad Mir etal, "**Review Paper on Use of Different types of Additives in DBM (Dense Bitumen Macadam**)" International Journal of Advanced Research in Education & Technology (IJARET) Vol.3, Issue 2 (April-June 2016)

[3]. S.C.Rangwala, " **Engineering Materials**", 20th edition, Charotar Publishers(2014)

[4]. Subramanian.K.., **" Highways, Railways, Airport and Harbour Engineering**", Scitech Publications (India),2010

[5]. S.K. Wasim Anwar etc. al "**Studies on Marshall and Modified Marshall specimens by using CRMP**", International Journal of Structural and Civil Engineering Research, Volume-3 ,No-4 (2014)

[6]. **IRC : 94 -1986**, Specification for Dense Bituminous Macadam

[7]. **IRC: 20 -1996**, Recommended Practice for Bituminous penetration Macadam

[8]. Specification for Bitumen Macadam, Indian Highways, August 2007.